

THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND
BINGE EATING

By

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Abstract

Binge eating (BE) affects over a third of the population of people seeking weight loss treatment (Yanovski, 2002). Because BE has a negative impact on weight loss (Yanovski, 2002), it is imperative to examine components of treatment leading to decreases in binge severity. The present study explores the relationship between physical activity (PA) and binge eating. One hundred twenty-seven participants seeking treatment for weight loss completed surveys measuring BE severity and depression level. In addition, participants recorded the number of minutes they engaged in weekly PA over a 9 month period. Results indicated that higher minutes of weekly PA was related to lower scores on a measure of BE severity between baseline and the end of a three month weight loss period. Findings are discussed in terms of the etiology of binge eating disorder and benefits of the addition of a PA component to standard treatments for BE.

The Association between Physical Activity and Binge Eating

Obesity has become a national epidemic and, consequently, much research has been devoted to its treatment (Fairburn & Brownell, 2002). Although many strategies have been found to facilitate weight loss, several problems have been identified that interfere with successful weight loss treatment. One maladaptive behavior complicating obesity treatment is binge eating, which consists of eating large amounts of food in a relatively short period of time. Recent research examining treatment strategies for binge eating has highlighted physical activity (PA) as a promising adjunct to treatment. In light of theories proposing that binge eating results as a means of controlling negative emotions and mood states, physical activity is believed to facilitate reductions in binge episodes through mood regulation (Pendelton, Goodrick, Poston, Reeves & Foreyt, 2002).

Binge eating is also proposed to be reduced through weight loss (Wilfley, 2002). Thus, in addition to the positive effects physical activity has on mood, physical activity may bring about reductions in binge eating through weight loss. The present study will examine the relationship between binge eating and physical activity. In addition, depression and weight loss will be explored as possible mediators in the relationship between binge eating and physical activity.

Binge Eating Disorder

Binge eating disorder (BED) has been linked to several physical and mental health maladies. One hallmark of this disorder is feelings of loss of control accompanied by binge eating (DSM-IV, 1994). In fact, suggested criteria for BED diagnosis include recurrent episodes of binge eating, defined as eating more food during a particular time frame than most people would eat during a similar time frame and feeling a lack or loss of control during the episode. In addition, episodes must occur at least two times a week for a minimum of six months, be associated with faster than normal eating, eating past the level of comfort or satiety, and eating alone due to embarrassment. Negative feelings, such as

guilt, remorse and depression often accompany and are triggered by binge episodes (DSM-IV, 1994). BED occurs in approximately 2% of the population and 8% of the overweight population (Bruce & Agras, 1992).

Overweight and obesity present one of the biggest physical health threats to binge eaters. Obese BED patients face the same threats to health as non-binging obese patients, such as increased risk of coronary heart disease (Willett et al., 1995), diabetes (Colditz et al., 1990; American Diabetes Association, 1992), hypertension, hyperlipidemia, gallbladder disease, respiratory disease, cancer, gout and arthritis (Pi-Sunyer, 1993). The problem of physical health sequela related to BED is compounded by evidence suggesting a link between BED and poorer weight-related treatment outcome. Specifically, the higher drop-out rates and lower weight losses experienced among those with BED appear to be mediated by psychological dysphoria (Yanovski, 2001).

Moreover, BED is characterized by a variety of comorbid psychological and cognitive maladies. Dysfunctional attitudes towards eating and body shape are a typical of BED (Grillo, 2002). Thus, increased body image dissatisfaction regarding weight and shape are commonly seen in patients with BED (Agras & Apple, 2002), in addition to negative self-esteem, problems with dietary restraint, and impaired social functioning (Grillo, 2002). Research on this population also indicates high levels of comorbid depression, anxiety disorders, substance abuse and personality disorders (Brewerton, 1999). Likewise, binge eaters have been shown to be particularly vulnerable to fear about the opinions of others, feelings that they are weak and inferior and feelings of shame, including rage, and self-consciousness. (Ricca, Mannucci, Zucchi, Rotella, & Faravelli, 2000).

BED Treatment

Due to the numerous negative physical and psychological problems associated with BED, scientifically validated treatment is imperative for this disorder. Accordingly, several empirically supported approaches to treatment have been developed. Of these treatments, three approaches,

psychopharmacological, interpersonal therapy, and cognitive behavioral therapy, stand out with respect to both quantity and robustness of empirical support (Wilfley, 2002; Devlin, 2002).

Although several successful BED treatment programs have been developed, most studies of successful treatments report that only fifty percent of participants are binge free at the end of treatment (Wilfley, 2002). Thus, several researchers have experimented with adding various components to psychological treatment programs in order to enhance standard treatment outcomes. These additions to treatment, which have been met with varying degrees of success, include spousal participation in treatment (Gorin, Le Grange, & Stone, 2003), extending treatment length (Eldredge et al., 1997), ecological momentary assessment (Le Grange, Gorin, Dymek, & Stone, 2002), combining treatment with medication (Agras, et al., 1994; Devlin, Goldfein, Carino, & Wolk, 2000; Grilo, Maseb & Wilson, 2005), combining treatment programs (e.g. interpersonal therapy and cognitive behavioral therapy) (Agras et. al, 1995), and the inclusion of an exercise component (Pendelton, Goodrick, Poston, Reeves & Foreyt, 2002; Fossati et al., 2004).

BED and Physical Activity

Combining an exercise component with standard BED treatments provides a potentially promising adjunct to treatment beyond reductions in binge eating. For example, two common comorbid features of binge eating, increased psychopathology (Grilo, 2002), in particular depression (Telch & Stice, 1998), and obesity (Bruce & Agras, 1992; Fariburn, Cooper, Doll, Norman, & Conner, 2000, Striegel-Moore et al., 2001) have been shown to be reduced by exercise (Grilo, Brownell, & Stunkard, 1993; Martinsen & Stephens, 1994). These findings have led researchers to theorize that physical activity may have an effect on binge eating by providing a means of weight loss and/or by ameliorating depression.

The relationship between physical activity and binge eating may be further elucidated through current theories of binge eating which suggest that binges are triggered by attempts to avoid or

compensate for negative feelings, such as depression, sadness, and anger (Polivy & Herman, 1993).

Binging is believed to provide a means of taking the focus off disturbing feelings an individual may be experiencing. Thus, physical activity may work to reduce binging by providing an alternate means of managing negative feelings, thereby reducing the urge to engage in binging behaviors.

Several studies highlight the relationship between binge eating and physical activity and the effect this relationship may have on weight loss and psychopathology. Although findings from these studies generally indicate a negative relationship between increased physical activity and a reduction in binge eating, explanations for this relationship vary among the articles. For example, Pendelton, Goodrick, Poston, Reeves and Foreyt (2002) found that 65% of BED (n=88) subjects undergoing cognitive-behavioral therapy combined with an exercise component showed significant improvement in binge frequency and lowered depression after 16 months of treatment. Only 18% of participants in this study who received CBT with no exercise intervention showed significant improvements in binge eating after an equal period of time. In addition, subjects in the exercise group also experienced greater weight loss compared to subjects in the standard CBT group. The authors propose that the decreases in binge eating in the CBT plus exercise group may be due to the mediating effects of depression. Although no analysis was performed to test this idea, the hypothesis is supported by research suggesting that exercise does, in fact, reduce depression levels (Ross & Hayes, 1988; Babyak et al., 1988; Martinsen, Medhus, & Sandvik, 1985).

Correspondingly, Fossati, Amati, Painot, Reiner, Haenni, and Golay (2004) found that exercise enhances outcomes in a BED treatment program. In this study, three groups of obese BED patients were randomized into one of three treatment possibilities: a purely cognitive-behavioral group (CBT), a CBT group with a nutrition component (CBTN), or a CBT group with a nutrition component and an exercise component (CBTN+PA). After a 12 week treatment program, weight loss was greatest for the CBTN+PA group ($p<.008$). In the CBTN+PA group, eating disorder and depression scores also

showed significant improvement above those found for the other groups. From these results, the authors suggest that exercise may serve as a motivating factor for development of more functional eating behaviors and thoughts (amelioration of eating disordered behaviors), which in turn enables weight loss. Thus, while not directly tested nor fully explained, this model posits that the relationship between exercise and weight loss is mediated by a reduction in eating disordered behaviors (including binge eating) and thoughts. Based on findings in the literature, however, this model proves problematic.

Although support can be found for a relationship between exercise and weight loss (Blair & Holder, 2002), and for a relationship between reduction of eating disordered behaviors and weight loss, findings for a relationship between exercise and eating disorder psychopathology suggest that exercise may contribute to disordered eating (Zabinski, Calfas, Gehman, Wilfley, & Sallis, 2001). Contrary to the authors notion that exercise may be responsible for reductions in eating disordered behaviors, findings in the literature indicate that exercise may actually *increase* eating disordered behaviors by contributing to increased concerns over and focus on thinness in women. (Zabinski, Calfas, German, Wilfley, & Sallis, 2001).

Further, the effects of BED treatment with a physical activity component on mood and weight loss present another research quandary. As noted above, two studies (Pendelton et al., 2002; Fossati et al., 2004) found that after BED treatment with an exercise component, patients showed improved mood and decreased weight. In both studies, the authors hypothesized that exercise reduces binge eating by decreasing depression levels and reducing weight. However, Levine, Marcus and Moulton (1994) found a relationship between exercise and binge eating in the absence of significant differences in depression and weight. Seventy-seven women in this study were randomized into a wait-list group, an exercise intervention group or a delayed exercise intervention group. After six months, only women who were abstinent from binge eating showed increased frequency of exercise. In addition, no

association between exercise status and weight or depression symptoms was found. These findings suggest that a relationship between exercise and binge eating may exist independent of mood level and weight loss.

Moreover, all four of the previously discussed studies examined binge eating using a sample of females. However, including males in research on binge eating appears important as studies also indicate that males do engage in binge eating behavior with nearly a 1:1 male to female ratio (Andersen, 2002; Spitzer et al., 1993). In addition, males differ in several characteristics of bingeing such as, types of foods consumed during a binge (LaPorte, 1997) and feelings experienced after engaging in binge eating (Leon, Carroll, Chernyk, & Finn, 1985). For example, whereas females typically experience negative feelings after binge episodes, males report feeling happy. (Leon, Carroll, Chernyk, & Finn, 1985).

Purpose of Study

The purpose of this study is twofold. Part one is an attempt to replicate the findings of previous research that a relationship exists between physical activity and binge eating. However, unlike previous studies, this study will involve a non-clinical community sample of overweight or obese individuals (i.e. overweight or obese people who are not seeking treatment for binge eating). This population is important to study as many people presenting for obesity treatment report engaging in binge eating, yet do not necessarily meet diagnostic criteria for BED. Because many studies to date have required a clinical diagnosis of BED for study participation, this population represents a sorely neglected sample in research.

Assuming a relationship between binge eating severity and physical activity is found, part two of the study will examine this association. Specifically, possible mediators of the relationship between physical activity and binge eating severity, including, BDI score and weight loss will be analyzed. In order to accomplish this, both the association between physical activity and BDI score/weight loss and

the relationship between BDI score/weight loss and binge eating severity will be explored

In order to determine whether physical activity predicts BES scores over time, the relationship between physical activity at time 2 and BES scores at the end of the weight loss period (time 3) will be examined. Further, the relationship between change in minutes of physical activity between time 2 and time 3 and BES scores at time 3 will be examined. Finally, in order to check whether results are confounded by gender differences, separate analysis will be performed for men and women.

Hypotheses

Primary

1. Higher minutes of reported physical activity will be associated with lower BES scores at the end of weight loss (time 2) and at the end of weight maintenance (time 3). Both depression and weight loss are expected to mediate this relationship.
2. Higher minutes of reported physical activity at the end of weight loss (time 2) will predict lower binge eating scores at the end of weight maintenance (time 3) and greater positive change in minutes of reported physical activity from time 2 to time 3 will predict lower BES scores.

Secondary

1. Gender differences are not expected to be found in this non-clinical (and thus potentially less symptomatic of BED) sample.

Methods

Participants

Approximately 213 participants completed study consent forms. Participants completing the intervention were 49 male (38.6%,) and 77 (60.6%) female individuals between the ages of 19 and 65 with a BMI between 25 and 39.9 who presented for a group weight loss program, the Weight Control Research Project, run by the University of Kansas Department of Sport and Exercise Physiology.

Program completers were primarily Caucasian (N=120, 94.5%). However, two (1.6%) African American and two (1.6%) Asian participants also took part in the study. One-quarter of the sample, 25.2% (N=32) were Hispanic, while 74% (N=94) participants reported being non-Hispanic. Eighty-six participants did not complete the study and were not included in analyses. Information about the reasons non-completers did not continue in the study was not collected for most individuals, nor was demographic information or information about number of potential participants who were not eligible for study participation. For individuals for whom information was gathered, reasons for dropping included problems with attendance, such as conflict with class time or scheduling, dietary issues, such as disliked diet, did not meet study attendance or weight loss requirements (see below) and unspecified personal reasons. Demographic information for 56 of those 86 non-completing participants was collected; non-completers had approximately the same demographic characteristics as completers (Table 1). All participants were recruited through local newspaper advertisements, fliers and referrals from previous weight loss group members.

Table 1

Demographics

	Droppers	Completers
Gender ^a		
Males	49 (38.6%)	23 (41.1%)
Females	77 (60.6%)	33(58.9%)
Race ^b		
Caucasian	120 (94.5%)	53 (94.6%)
African/Black	2 (1.6%)	2 (3.6%)
Asian	2 (1.6%)	--
Native American/Alaskan Native	1 (1.8%)	
Ethnicity		
Hispanic/Latino	32 (25.2%)	10 (17.9%)
Non-Hispanic/non-Latino	94 (74%)	46 (82.1%)
Mean Baseline BMI	34.48	36.08

Note. ^aOne completer did not complete this information. ^bThree completers did not complete this information.

*Measures**Binge Eating Scale*

The Binge Eating Scale (BES) is a 16-item-self report measure designed to assess binge eating severity (i.e. amount of food eaten during a binge, frequency of episodes and degree of emotionality) in an obese population (Gormally, Black, Daston, & Rardin, 1982). Several features of binge eating are measured with this scale, including both behavior and feelings and cognitions associated with binge eating. The BES has demonstrated adequate test-retest reliability ($\kappa=.87$; Timmerman, 1999),

internal consistency ($\alpha=.89$) and has been found to discriminate between individuals with no, moderate and severe binge problems (Marcus, Wing & Hopkins, 1988). Higher scores on the BES indicate a more severe level of binge eating. Several studies have used a cut off score of ≥ 27 for severe binge eating (Marcus, et al, 1988; Telch & Agras, 1994). Alpha coefficients for this investigation were .87 (time 1), .87 (time 2), and .89 (time 3).

Beck Depression Inventory

The Beck Depression Inventory (BDI) is a 21 item self-report scale measuring the cognitive, affective and somatic symptoms of depression (Beck, Ward, Mendelson, Mach and Erbaugh, 1961). Scores on the BDI range from 0-63, with higher scores indicating greater depression severity. Scores at or below 9 suggest that a person is not depressed, 10–18 suggests mild-moderate depression, 19–29 suggests moderate-severe depression and scores at or above 30 suggest severe depression (Shaw et al., 1985). The BDI has been shown to have adequate internal consistency, ranging from $\alpha=.73-.92$ (Beck, Steer, & Garbi, 1988) and Groth-Marnat (1990) reported test-retest reliability to range from .48 to .86 depending on the population of participants and the time between tests. In this study, alpha coefficients for the BDI were .97 (time 1), .98 (time 2) and .98 (time 3).

Weight loss

Weight loss was measured weekly at the beginning of lifestyle clinics. The participants individually entered a room with the lifestyle group leader. Weight was measured with a standard scale and recorded by the group leader and was calculated by subtracting weights at the two points of time of interest. For example, weight loss for time 2 was calculated by subtracting weight at time 2 from weight at time 1.

Physical Activity

Physical activity was assessed by self-report of participants. At the beginning of lifestyle clinics, participants reported to the lifestyle group leader the total number of minutes spent engaging in

moderate intensity aerobic activity for the week. Activity included jogging, walking, biking, and other aerobic activities engaged in specifically for the purpose of exercise. Participants were instructed that work-related and domestic activities (such as mowing the lawn and cleaning) were not to be included in weekly totals of physical activity. Data was reported confidentially to the lifestyle group leader. Total PA minutes were calculated for both time 2 and time 3 by averaging weekly minutes two weeks before and two weeks after the time point (i.e. time two PA is the average PA reported for weeks 11, 12, 13, 14 and 15). Averaging PA minutes across several weeks was intended to give a more accurate picture of minutes of PA participants were engaging in around the time period of interest. For purposes of predicting BES scores over time from change in minutes of PA, change in PA was calculated by subtracting minutes of PA at time 3 from minutes of PA at time 2.

Intervention

Data for this study was obtained from a weight management intervention implemented by the Kansas Weight Management Program (KWMP). The goals of this program are to conduct research on weight management, metabolism, and energy balance and to train faculty and graduate students involved in this area of research. The present study consisted of a 9 month intervention designed to examine the role of dairy consumption on weight maintenance after a period of weight loss. Participants enrolled in the study paid a \$250 deposit that was returned to them after completion of the program. In addition, participants received \$200 for compensation at study end. Participants were expected to lose weight by adhering to a prescribed diet, engaging in a set number of minutes of weekly physical activity, increasing the number of steps taken each day, and attending lifestyle clinics. Data was collected weekly, including number of steps taken (recorded by a pedometer), number of minutes of physical activity engaged in, and number of servings of fruits and vegetables consumed.

Weight Loss

Weeks 1-12 of the intervention were considered the weight loss period. During this time,

participants were placed on a low-calorie diet. Participants were expected to take in 1200 calories per day by consuming two shakes and two entrees provided by the KWMP, 5 one cup servings of fruits and vegetables (high calcium vegetables excluded) and 3 grams of meat per day. This diet was expected to facilitate a 12% loss of participant's baseline weight by week twelve of the program. Because the primary purpose of the intervention was to examine the role of dairy consumption on weight loss maintenance after a period of weight loss, those participants who failed to lose at least 10% of their baseline weight by week 12 were released from program participation.

Weeks 13-36 of the program were considered the weight maintenance portion of the program. During this period, participants were expected to maintain a 10% loss of their baseline weight and were told to consume five servings of fruits and vegetables per day in addition to calories from other foods to achieve an appropriate amount of calories for weight maintenance. Participants were randomized into two groups at this point in the study. Participants in the low dairy group were told to eat 0-1 servings of dairy daily; participants in the high dairy group were told to eat 3 or more dairy servings per day. Both groups completed monthly 3-day food logs in which all foods and beverages consumed over a 3-day period were recorded.

Physical Activity

At program start, it was assumed that all participants were sedentary. Participants were instructed to begin engaging in moderate intensity activity approximately three to five times per week for a total of 45 minutes per week, increasing minutes of activity weekly. By week 13, all participants were expected to be participating in physical activity not to exceed 150 minutes per week.

Lifestyle Clinics

During treatment participants were required to attend at least 75% of weekly 90 minute lifestyle clinics. These clinics focused on topics about nutrition (portion control, reading food labels, cooking demonstrations, etc.) physical activity (demonstrations of various activities such as yoga and aerobic

workouts, injury prevention and exercise myths) and behavior change and psychological factors (emotional eating, stress reduction, appropriate goal setting, etc.). Graduate students in the appropriate areas (sport and exercise science, nutrition and clinical psychology) led topics and meetings were facilitated by demonstrations, lectures, speakers, physical participation and the sharing of group member's thoughts and struggles throughout the process. All members were expected to be active participants of each clinic. Participants who did not attend at least 75% of these clinics were excluded from the study.

Table 2

Means

	Time 1	Time 2	Time 3
	Baseline	3 months	9 months
Physical Activity	--	155.98 (55.61)	133.16 (34.43)
Binge Eating Scale (BES)	30.55 (6.76) ^a	25.1 (5.73) ^b	24.19 (5.75) ^c
Beck Depression Inventory (BDI)	13.59 (10.69)	9.83 (10.82) ^b	9.78 (10.52) ^c

Note. Standard deviations shown in parathesis.

Note. ^aData from 9 participants was missing. ^bData from 1 participant was missing. ^cData from 7 participants was missing.

Procedures

The purpose of the study from which these data were obtained was to examine differences in weight loss maintenance after a period of weight loss with a low dairy versus a high dairy diet. Participants in both groups were required to have a BMI in the range of 25 to 39.9 at baseline and consent to program requirements. Participants in the program were required to report data (including minutes of physical activity & number of steps taken) to their group leader weekly, collect 3-day food records monthly, and consent to baseline, 3, 6 and 9 month testing/measurement including resting

metabolic rate, 12 hour fasting blood draw, dual energy x-ray absorptiometry, waist circumference, blood pressure, heart rate, weight and height. In addition, all participants filled out behavioral and medication/supplementation questionnaires at 3, 6 and 9 months. Females in the program were required to take pregnancy tests.

Statistical Analysis

Cross Sectional Relationships

In order to determine whether a relationship existed between binge eating severity and physical activity, a linear regression analysis was performed along with visual inspections of scatter plots. Separate analyses were conducted at two time points: time 2, end of weight loss (3 months) and time 3, end of maintenance (9 months).

Using regression analysis, three steps were performed in order to explore depressive symptoms as a mediator in the relationship between physical activity and binge eating (Table 3). First, a linear regression was performed to examine the relationship between physical activity and BDI score. Next, this analysis was repeated with BDI score and BES score. Finally, physical activity and BDI score were entered into the model simultaneously in order to determine if mediation occurred.

To determine the potential mediating role of weight loss, the previous three steps were repeated substituting weight loss for BDI score as the mediating variable (Table 4). In addition, the data was split to explore any associations due to gender.

Relationships Over Time

In order to determine if PA predicts binge eating over time, a regression analysis was performed such that PA at time 2 was used to predict binge eating at time 3. Further, change in PA between time 2 and time 3 was used to predict binge eating at time 3 using regression analysis (Table 5).

Results

Cross Sectional Relationships

Visual examination of a scatterplot at time 2 revealed a negative linear relationship between physical activity and BES scores, specifically, higher minutes of PA were associated with lower BES scores. Correspondingly, a regression analysis of the data revealed that higher minutes of physical activity were related to lower BES scores ($\beta = -.23$, $p = .01$, $r^2 = .05$), and accounted for 5% of the variance in binge eating severity. A relationship was found both between physical activity and BDI score ($\beta = .34$, $p = .00$, $r^2 = .12$) and between BDI and BES score ($\beta = .18$, $p = .05$, $r^2 = .02$). Further, in order to determine whether BDI score mediates the relationship between physical activity and binge eating severity, a regression analysis was run with both BDI score and PA in the model. Results of this analysis confirmed that PA continued to be associated with BES scores with BDI scores in the model ($\beta = -.31$, $p = .00$, $r^2 = .10$). Therefore, BDI score was not found to mediate the relationship between PA and BES score.

Table 3

Summary of regression analysis for BDI as a mediator

Variable	B	SE B	β	ΔF	R^2	ΔR
BES						
Step 1 (Physical activity)				6.801*	.05	
Minutes of reported PA	-.03	.01	-.23*			
Step 2 (BDI)				5.981*	.10	.05
Minutes of reported PA	-.04	.01	-.31**			
BDI score	.12	.05	.23*			

Note. * $p < .05$; ** $p < .01$

After establishing the relationship between physical activity and binge eating severity at time 2,

analyses were performed to determine whether weight loss mediated this relationship. Physical activity was found to be positively related to weight loss ($\beta=.19$, $p=.04$, $r^2=.04$). A negative linear relationship was also found between weight loss and BES score ($\beta= -.19$, $p=.03$, $r^2=.04$), such that greater weight loss was associated with lower BES scores. However, weight loss did not appear to mediate the relationship between PA and BES score at time 2. When both weight loss and physical activity were entered into the model, physical activity continued to be associated with BES score ($\beta= -.22$, $p=.01$, $r^2=.10$).

Table 4

Summary of regression analysis for weight change as a mediator

Variable	B	SE B	β	ΔF	R^2	ΔR
BES						
Step 1 (Physical activity)				6.801*	.05	
Minutes of reported PA	-.03	.01	-.23*			
Step 2 (weight change)				5.602*	.04	.10
Minutes of reported PA	-.03	.01	-.23*			
T1 weight – T2 weight	.27	-.11	.21*			

Note. * $p<.05$

In order to determine whether differences existed between men and women in the physical activity and binge eating relationship, the data file was split between men and women. Although the sample size was too small to achieve adequate power for a significant finding, the trends were the same for men and women. In both groups, an increase in physical activity was associated with a decrease in binge eating (time 2: men: $\beta= -.04$, $p=.77$, women: $\beta=-.14$, $p=.23$; time 3: men: $\beta=-.009$, $p=.95$, women: $\beta=.06$, $p=.61$).

Similar to time 2, scatterplots at time 3 suggested a linear relationship between physical activity and binge eating severity. However, upon analysis of the results of a linear regression, no relationship

was found between these two variables at time 3 ($\beta=.02$, $p=.87$). In addition, no relationship was found between physical activity and BDI scores at time 3 ($\beta=.01$, $p=.95$) nor between BDI scores and BES scores ($\beta=.03$, $p=.75$).

Relationships Over Time

In the attempt to determine whether physical activity at time two was predictive of BES score at time 3, another regression analysis was conducted ($\beta=-.02$, $p=.80$). In addition, a similar analysis was conducted to explore whether a change in physical activity between time 2 and time 3 was predictive of binge eating severity at time 3 ($\beta=.08$, $p=.42$). However, neither of these findings of reached significance (Table 5).

Table 5

Prediction of Binge Eating

	B	SE B	β
BES (time 3)			
Physical activity (time 2)	.00	.01	-.02
BES (time 3)			
Weight change (time 3-time 2)	.01	.01	.08

Note. $R=.02$ for BES time 3 and PA time 2 prediction. $R=.01$ for BES time 3 and weight change time3-time 2 prediction.

Discussion

This study set out to examine the relationship between binge eating severity and physical activity. Although a limited number of studies have explored this relationship, the present study is unique in its focus on binge eaters who are seeking treatment for weight loss rather than binge eating per se. Correspondingly, this study is distinctive in its exploration of the association between physical activity and binge eating severity in the absence of a treatment program specifically designed to target

binge eating.

Results of the present study suggest that although physical activity level is not predictive of binge eating severity, lower scores on a measure of binge eating severity are associated with higher weekly minutes of PA when participants engage in a weight loss program consisting of lifestyle clinics, physical activity and dietary changes. Although binge eating severity scores were related to depression scores at the end of the three month weight loss period, no relationship was found between binge eating severity scores and physical activity at any other time point. This finding is similar to findings by Pendleton, Goodrick, Poston, Reeves, and Foreyt, (2002), demonstrating a relationship between PA and binge eating only at month 4 of a 16 month exercise program. Although the authors of that study explain those findings in terms of they type of exercise (work related vs. leisure related activity) impacting binge eating levels, they do not directly address why this association was seen only at 4 months. In the present study, the finding that there is a relationship between lower binge eating scores and higher minutes of physical activity only at the end of the weight loss period and not at the end of weight maintenance may be explained by a decrease in the amount of variance in physical activity scores at the end of weight maintenance as compared to the scores at the end of the weight loss period (Table 2). In addition, the mean minutes of physical activity per week was lower for later time points, although not enough to reach significance.

Findings of the present study also indicate that although average BDI scores were lower at the end of the weight loss period, these scores did not mediate the relationship between binge eating severity and physical activity. Although interpretation of this result should be made with caution because mean BDI scores in this sample ranged between mild depression and no depression, these results are somewhat surprising given the current belief that binge eating develops as a result of emotion dysregulation and as a means to mitigate negative mood states (Polivy & Herman, 1993). Further, as stated previously in this paper, depression has been shown to be reduced by an increase in

exercise (Ross & Hayes, 1988; Babyak et al., 1988, Martinsen, Medhus, & Sandvik, 1985). One possible explanation why these findings may not coincide with previous ideas about depression as a mediator in the relationship between PA and binge eating is that although emotion regulation is a struggle for binge eaters and may co-occur with binge eating, it may not fully account for the underlying etiology of binge eating. For example, several recent studies have suggested that impulsivity may be a causative agent in binge eating rather than emotion dysregulation (Nasser, Gluck, & Geliebter, 2004; Galanti, Gluck, and Geliebter, 2007; Raymond, et al., 1999). In support of this theory is evidence demonstrating that although “low mood” is more common on binge days, it does not directly precede binge episodes (Wegner, et al., 2002). Moreover, in a separate study examining the most common times that binges occur, Allison & Timmerman (2007) found that binge eating episodes happen most commonly during mealtime, i.e. when binge eaters are exposed to food. This may provide evidence that binge episodes occur as a result of impulsivity when a person prone to binges is exposed to food. Thus, findings in the current study demonstrating that physical activity is associated with less severe binge eating independent of depression may lend further support to the notion that binge eating is not solely dependent on mood dysregulation.

Finally, results of this study also indicated that binge eating is related to physical activity independent of weight loss at all time points. Results of several studies have shown that behavioral weight loss treatments designed to reduce weight have also been effective in decreasing binge eating (Yanovski, 2002). However, results of the present study suggest that there is a negative relationship between physical activity and binge eating severity beyond the relationship between both weight loss and binge eating and weight loss and physical activity. This finding may indicate that physical activity may play a role in the reduction of binge eating independent of weight loss.

Limitations

Limitations of this study include generalizability due to the limited range of participant

demographic variables. Specifically, participants in this program were primarily Caucasian. This, in particular, may restrict generalizability to other binge eating populations, as previous research has shown that differences in binge eating correlates vary among racial and ethnic groups (Fitzgibbon, Spring, Avellone, Blackman, Pingitore, Stolley, 1998; Bennet & Dodge, 2007). Moreover, participants in this study reported being sedentary at baseline. Because the only significant association between physical activity and binge eating was seen between time 1 and time 2, it is possible that using a population with varying degrees of physical activity at baseline may have produced different findings.

In addition, the large number of participants who did not complete the program is a significant concern. This concern is amplified by the paucity of information regarding reasons non-completers terminated the program or were terminated from program participation. The lack of information regarding this issue puts into question whether these findings can be generalized. Without data stipulating why participants did not complete the program, it is impossible to understand for which groups of people these results may not be applicable. For example, if participants who had the most severe binge eating were those who were excluded from participation because they did not meet the 3 month 10% weight loss criteria, these results would not be applicable to those with more severe cases of binge eating.

Further, BDI scores for this sample were relatively low (Table 2). At baseline, participants had the highest mean depression scores (13.59), indicating mild to moderate depression. For time 2 and time 3, participants mean BDI scores was below the typical cut off for depression. Had scores on the BDI been higher, it is possible that depression scores might have been found to mediate the relationship between PA and BES scores.

The randomization of participants into two different treatment groups might have also impacted study results. However, although there is some indication that certain types of foods are more likely to

be consumed during a binge episode (i.e. foods high in fat and low in protein; Yanovski, 2002), to date, no published study has reported on an association between binge eating severity and dairy consumption. This, of course, does not necessarily mean that no association exists. Thus, without analyses specifically examining differences in changes in BES scores between treatment groups, it is impossible to determine if randomization had an impact on the results of this study.

Further, the measurement instruments used in this study may have also limited findings. Although the BES is a widely used assessment instrument for binge eating severity, a structured diagnostic interview is currently considered the gold star standard for assessment of binge eating (Agras & Apple, 2002). Although use of this interview may have given a more accurate diagnosis of binge eating disorder, one of the benefits of this study is that it is specifically designed to examine binge eaters who are seeking treatment for weight loss rather than binge eating. Inclusion of individuals who likely did not meet diagnostic criteria for BED, yet who clearly struggle with binge eating (indicated by higher scores on the BES), serves an important role in terms of examining strategies that may be useful for reduction of subclinical binge eating.

Directions for Future Research

The results of this study shed light on several areas in need of research. One of the most surprising findings of this study is that although BDI score was related to binge eating severity, it did not mediate the relationship between physical activity and binge eating severity. As noted earlier in this paper, findings of previous research indicate a relationship between physical activity and binge eating have been explained in terms of a possible mediating role of depression. It appears that this may not be the case, at least not in all samples of binge eaters. Further exploration of the underlying causes of binge eating is warranted. This is especially true given recent research challenging the role low mood plays in the onset of binge episode (Wegner, et al., 2002)) and the times that binges occur, namely at mealtimes, rather than immediately following a triggering event (Allison & Timmerman,

2007).

Further research is also needed examining the specific reasons that physical activity may play a role in severity level of binge eating. One approach to this might be to perform an in depth exploration of specific eating disordered behaviors that are associated with increased physical activity. Another approach that may prove useful, especially given the burgeoning evidence for the role of impulsivity in binge eating, might be to examine the role of physical activity on impulsivity.

Findings of this study suggest that physical activity may play an important role in binge eating severity while undergoing weight loss treatment. Although the specific role physical activity plays remains unclear, it seems likely that treatment programs designed specifically for people struggling with binge eating would benefit from the addition of a physical activity component.

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Appendix A

Binge Eating Scale

Directions: Below are 16 groups of statements. Read all of the statements in each group and check the one in each group that best describes the way you feel about the problem you may have controlling your eating behavior.

A.

- ☐ 1. I don't feel self-conscious about my weight or body size when I am with others.
- ☐ 2. I feel concerned about how I look to others, but it normally does not make me feel disappointed with myself.
- ☐ 3. I do get self-conscious about my appearance and weight which makes me feel disappointed in myself.
- ☐ 4. I feel very self-conscious about my weight and frequently, I feel intense shame and disgust for myself. I try to avoid social contacts because of my self-consciousness.

B.

- ☐ 1. I don't have any difficulty eating slowly in the proper manner.
- ☐ 2. Although I seem to "gobble down" foods, I don't end up feeling stuffed because of eating too much.
- ☐ 3. At times, I tend to eat quickly and then, I feel uncomfortably full afterwards.
- ☐ 4. I have the habit of bolting down my food, without really chewing it. When this happens, I usually feel uncomfortably stuffed because I've eaten too much.

C.

- ☐ 1. I feel capable of controlling my eating urges when I want to.
- ☐ 2. I feel like I have failed to control my eating more than the average person.
- ☐ 3. I feel utterly helpless when it comes to feeling in control of my eating urges.
- ☐ 4. Because I feel so helpless about controlling my eating I have become very desperate about trying to get in control.

D.

- ☐ 1. I don't have the habit of eating when I'm bored.
- ☐ 2. I sometimes eat when I'm bored, but often I'm able to "get busy" and get my mind off food.
- ☐ 3. I have a regular habit of eating when I am bored, but occasionally I can use some other activity to get my mind off eating.
- ☐ 4. I have a strong habit of eating when I'm bored. Nothing seems to help me break the habit.

E.

- ☐ 1. I'm usually physically hungry when I eat something.
- ☐ 2. Occasionally, I eat something on impulse even though I really am not hungry.
- ☐ 3. I have the regular habit of eating foods that I might not really enjoy to satisfy a hungry feeling, even though physically I don't need the food.
- ☐ 4. Even though I'm not physically hungry, I get a hungry feeling in my mouth that only seems to be satisfied when I eat a food, like a sandwich, that fills my mouth. Sometimes, when I eat the food to satisfy my mouth hunger, I then spit the food out so I won't gain weight.

F.

- ☐ 1. I don't feel any guilt or self-hate after I overeat.
- ☐ 2. After I overeat, occasionally I feel guilt or self-hate.
- ☐ 3. Almost all the time I experience strong guilt or self-hate after I overeat.

G.

- ☐ 1. I don't lose control of my eating when dieting even after periods when I overeat.
- ☐ 2. Sometimes when I eat a "forbidden food" on a diet, I feel like I "blew it" and eat even more.
- ☐ 3. Frequently, I have the habit of saying to myself, "I've blown it now, why not go all the way" when I overeat on a diet. When that happens I eat even more.
- ☐ 4. I have a regular habit of starting strict diets for myself, but I break the diets by going on an eating binge. My life seems to be either a "feast" or a "famine".

H.

- ☐ 1. I rarely eat so much food that I feel uncomfortably stuffed afterwards.
- ☐ 2. Usually about once a month, I eat such a quantity of food I end up feeling very stuffed.
- ☐ 3. I have regular periods during the month when I eat large amounts of food, either at mealtime or at snacks.
- ☐ 4. I eat so much food that I regularly feel quite uncomfortable after eating and sometimes a bit nauseous.

I.

- ☐ 1. My level of calorie intake does not go up very high or go down very low on a regular basis.
- ☐ 2. Sometimes after I overeat, I will try to reduce my calorie intake to almost nothing to compensate for the excess calories I have eaten.
- ☐ 3. I have a regular habit of overeating during the night. It seems that my routine is not to be hungry in the morning but overeat in the evening.
- ☐ 4. In my adult years, I have had week-long periods when I practically starve myself. This follows periods when I overeat. It seems I live a life of either "feast" or "famine".

J.

- ☐ 1. I usually am able to stop eating when I want to. I know when "enough is enough".
- ☐ 2. Every so often, I experience a compulsion to eat which I can't seem to control.
- ☐ 3. Frequently, I experience strong urges to eat which I seem unable to control, but at other times I can control my eating urges.
- ☐ 4. I feel incapable of controlling urges to eat. I have a fear of not being able to stop eating voluntarily.

K.

- ☐ 1. I don't have any problem stopping eating when I feel full.
- ☐ 2. I usually can stop eating when I feel full but occasionally overeat leaving me feeling uncomfortably stuffed.
- ☐ 3. I have a problem stopping eating once I start and usually I feel uncomfortably stuffed after I eat a meal.
- ☐ 4. Because I have a problem not being able to stop eating when I want, I sometimes have to induce vomiting to relieve my stuffed feeling.

L.

- ☐ 1. I seem to eat just as much when I'm with others (family, social gatherings) as when I'm by myself.
- ☐ 2. Sometimes, when I'm with other persons, I don't eat as much as I want to eat because I'm self-conscious about my eating.
- ☐ 3. Frequently, I eat only a small amount of food when others are present, because I'm very embarrassed about my eating.
- ☐ 4. I feel so ashamed about overeating that I pick times to overeat when I know no one will see me. I feel like a "closet eater".

M.

- ☐ 1. I eat three meals a day with only an occasional between-meal snack.
- ☐ 2. I eat three meals a day, but I also normally snack between meals.
- ☐ 3. When I am snacking heavily, I get in the habit of skipping regular meals.
- ☐ 4. There are periods when I seem to be continually eating, with no planned meals.

N.

- ☐ 1. I don't think much about trying to control unwanted eating urges.
- ☐ 2. At least some of the time, I feel my thoughts are preoccupied with trying to control my eating urges.
- ☐ 3. I feel that frequently I spend much time thinking about how much I ate or about trying not to eat anymore.
- ☐ 4. It seems to me that most of my waking hours are preoccupied by thoughts about eating or not eating. I feel like I'm constantly struggling not to eat.

O.

- ☐ 1. I don't think about food a great deal.
- ☐ 2. I have strong cravings for food but they last only for brief periods of time.
- ☐ 3. I have days when I can't seem to think about anything else but food.
- ☐ 4. Most of my days seem to be preoccupied with thoughts about food. I feel like I live to eat.

P.

- ☐ 1. I usually know whether or not I'm physically hungry. I take the right portion of food to satisfy me.
- ☐ 2. Occasionally, I feel uncertain about knowing whether or not I'm physically hungry. At these times it's hard to know how much food I should take to satisfy me.
- ☐ 3. Even though I might know how many calories I should eat, I don't have any idea what is a "normal" amount of food for me.

Beck Depression Inventory

Directions: This questionnaire is about YOURSELF. On this questionnaire are groups of statements. Please read each group of statements carefully. Then pick out the one statement in each group which best describes the way you have been feeling the PAST WEEK, INCLUDING TODAY. Check the box next to the statement you picked. If several statements in the group seem to apply equally well, check each one. Be sure to read all the statements in one group before making your choice. Then move on to the next group of sentences.

A.

- 0. ☐ I do not feel sad.
- 1. ☐ I feel blue or sad.
- 2a. ☐ I am blue or sad all the time and I can't snap out of it.
- 2b. ☐ I am so sad or unhappy that it is very painful.
- 3. ☐ I am so sad or unhappy that I can't stand it.

B.

- 0. ☐ I am not particularly pessimistic or discouraged about the future.
- 1. ☐ I feel discouraged about the future.
- 2a. ☐ I feel I have nothing to look forward to.
- 2b. ☐ I feel that I won't ever get over my troubles.
- 3. ☐ I feel that the future is hopeless and that things cannot improve.

C.

- 0. ☐ I do not feel like a failure.
- 1. ☐ I feel I have failed more than the average person.
- 2a. ☐ I feel I have accomplished very little that is worthwhile or that means anything.
- 2b. ☐ As I look back on my life all I can see is a lot of failures.
- 3. ☐ I feel I am a complete failure as a person (parent, husband, wife).

D.

- 0. ☐ I am not particularly dissatisfied.

- 1a. ☐ I feel bored most of the time.

- 1b. ☐ I don't enjoy things the way I used to.

- 2. ☐ I don't get satisfaction out of anything any more.

- 3. ☐ I am dissatisfied with everything.

E.

- 0. ☐ I don't feel particularly guilty.

- 1. ☐ I feel bad or unworthy a good part of the time.

- 2a. ☐ I feel quite guilty.

- 2b. ☐ I feel bad or unworthy practically all the time now.

- 3. ☐ I feel as though I am very bad or worthless.

F.

- 0. ☐ I don't feel I am being punished.

- 1. ☐ I have a feeling that something bad may happen to me.

- 2. ☐ I feel I am being punished or will be punished.

- 3a. ☐ I feel I deserve to be punished.

- 3b. ☐ I want to be punished.

G.

- 0. ☐ I don't feel disappointed in myself.

- 1a. ☐ I am disappointed in myself.

- 1b. ☐ I don't like myself.

- 2. ☐ I am disgusted with myself.

- 3. ☐ I hate myself.

H.

- 0. ☐ I don't feel any worse than anybody else.

- 1. ☐ I am very critical of myself for my weaknesses or mistakes.

- 2a. ☐ I blame myself for everything that goes wrong.
 2b. ☐ I feel I have many bad faults.

I.

0. ☐ I don't have any thoughts of harming myself.
 1. ☐ I have thoughts of harming myself, but I would not carry them out.
 2a. ☐ I feel I would be better off dead.
 2b. ☐ I have definite plans about committing suicide.
 2c. ☐ I feel my family would be better off if I were dead.
 3. ☐ I would kill myself if I could.

J.

0. ☐ I don't cry any more than usual.
 1. ☐ I cry more now than I used to.
 2. ☐ I cry all the time now, I can't stop.
 3. ☐ I used to be able to cry, but now I can't cry at all even though I want to.

K.

0. ☐ I am no more irritated now than I ever am.
 1. ☐ I get annoyed or irritated more easily than I used to.
 2. ☐ I feel irritated all the time.
 3. ☐ I don't get irritated at all at the things that used to irritate me.

L.

0. ☐ I have not lost interest in other people.
 1. ☐ I am less interested in other people now than I used to be.
 2. ☐ I have lost most of my interest in other people and have little feelings for them.
 3. ☐ I have lost all my interest in people and don't care about them..

M.

0. ☐ I make decisions about as well as ever.
 1. ☐ I am less sure of myself now and try to put off making decisions.
 2. ☐ I can't make decisions any more without help.

3. ☐ I can't make any decisions at all any more.

N.

0. ☐ I don't feel I look any worse than I used to.
 1. ☐ I am worried that I am looking old or unattractive.
 2. ☐ I feel that there are permanent changes in my appearance and they make me look unattractive.
 3. ☐ I feel that I am ugly or repulsive looking.

O.

0. ☐ I can work about as well as before.
 1a. ☐ It takes extra effort to get started at doing something.
 1b. ☐ I don't work as well as I used to.
 2. ☐ I have to push myself very hard to do anything.
 3. ☐ I can't do any work at all.

P.

0. ☐ I can sleep as well as usual.
 1. ☐ I wake up more tired in the morning than I used to.
 2. ☐ I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
 3. ☐ I wake up early every day and can't get more than 5 hours sleep.

Q.

0. ☐ I don't get any more tired than usual.
 1. ☐ I get tired more easily than I used to.
 2. ☐ I get tired from doing anything.
 3. ☐ I get too tired to do anything.

R.

0. ☐ My appetite is no worse than usual.
 1. ☐ My appetite is not as good as it used to be.
 2. ☐ My appetite is much worse now.
 3. ☐ I have no appetite at all any more.

S.

0. ☐ I am no more concerned about my health than usual.
 1. ☐ I am concerned about aches and pains *or* upset stomach *or* constipation *or* other unpleasant feelings in my body.

2. ☐ I am so concerned with how I feel or what I feel that it's hard to think of much else.
3. ☐ I am completely absorbed in what I feel.

T.

0. ☐ I have not noticed any recent change in my interest in sex.
1. ☐ I am less interested in sex than I used to be.
2. ☐ I am much less interested in sex now.
3. ☐ I have lost interest in sex completely